VIRUDHUNAGAR HINDU NADARS' SENTHIKUMARA NADAR COLLEGE

(An Autonomous Institution Affiliated to Madurai Kamaraj University)

[Re-accredited with 'A' Grade by NAAC]

Virudhunagar – 626 001.

Course Name : Master of Science
Discipline : Zoology
CHOICE BASED CREDIT SYSTEM
(For those who join in June 2022 and after)
COURSE SCHEME:

Semester	Part	Subject	Hours	Credit	Int+Ext =Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject code	Revised/ New/ No Change/ Interchanged. (If revised % of change)
I	Core 1	Cell and Molecular Biology	6	4	40+60=100			✔					✓	✓			P22ZYC11	Revised 30%
	Core 2	Biochemistry	6	4	40+60=100			✔		✓			✓	✓			P22ZYC12	Revised 40%
	Core 3	Techniques in Biology	6	4	40+60=100			✔		✓					✓		P22ZYC13	Revised 20 %
	Elective-1	Aquaculture	6	4	40+60=100			✔		✓					✓		P22ZYE11	Revised 10 %
	Core 4	LAB: Cell and Molecular Biology	3	3	40+60=100			✔								✓	P22ZYP11	Revised 20%
	Core 5	LAB : Biochemistry	3	3	40+60=100			✔								✓	P22ZYP12	Revised 20%
II	Core 6	Molecular Genetics	6	4	40+60=100			✔		✓			✓	✓			P22ZYC21	Revised 40%
	Core 7	Ecology	6	4	40+60=100			✔					✓	✓			P22ZYC22	Revised 30%
	Core 8	Biostatistics and Bioinformatics	6	4	40+60=100			✔					✓		✓		P22ZYC23	Revised 10%
	NME	Economic Zoology	6	4	40+60=100			✔					✓		✓		P22ZYN21	Revised 10%
	Core 9	LAB : Molecular Genetics	3	3	40+60=100			✔								✓	P22ZYP21	Revised 10%
	Core 10	LAB : Ecology	3	3	40+60=100			✔								✓	P22ZYP22	Revised 10%

SEMESTER - I

CORE: 1 - CELL AND MOLECULAR BIOLOGY

Contact hours per Semester – 90 hours **Credits: 4**

Contact hours per Week – 6 hours **Subject Code: P22ZYC11**

COURSE OUTCOMES

Upon successful completion, the students will have the knowledge and skills to:

CO1: Explain the ultrastructure and functions of subcellular organelles at molecular level in an animal cell

CO2: Illustrate that fundamental structural units define the function of all living things

CO3: Apply concepts from other sciences to interpret the cellular processes

CO4: Understand the nature of cancer and the processes underlying cancer formation and progression

CO5: Identify and explain the important checkpoints that a cell passes through during the cell cycle

Unit – I **(18 hours)**

Biomembranes: Molecular organization; transmembrane domains – transport across membrane: passive transport: diffusion and facilitated diffusion – active transport: ion channels; active transport driven by ATP hydrolysis; ion gradients – cell-cell adhesion: selectins; immunoglobulin superfamily; cadherins – Basic elements of cell signalling: Cell surface receptors; second messenger system; signaling from plasma membrane to nucleus

Unit II **(18 hours)**

Organization and functions of mitochondria: oxidative metabolism in mitochondria; electron transport complexes.

Structure and functions of peroxisomes: diseases associated with peroxisomal functions.

Ultrastructure and functions of Endoplasmic Reticulum: synthesis of secretory proteins; membrane biosynthesis; glycosylation of proteins; destruction of misfolded proteins

Organization and functions of Golgi complex: protein glycosylation; lipid and polysaccharide metabolism; protein sorting and export; mechanism of vesicular transport

Organization and functions of Lysosomes: lysosomal storage disorders

Unit III **(18 hours)**

Ultrastructure of interphase nucleus; nuclear envelope and nuclear pore; transport of molecules through nuclear pores – Levels of organization of chromosome: structure of metaphase chromosome; Euchromatin and heterochromatin: constitutive and facultative heterochromatin; X Chromosome inactivation and histone modification – giant chromosome – nucleolus

Unit IV **(18 hours)**

Phases of Cell cycle: G_0, G_1, S, G_2 Phases and M Phase: formation of mitotic chromosome; molecular organization of mitotic spindle; spindle assembly and chromosome attachment; cytokinesis; cell cycle checkpoints; Regulators of cell cycle progression: protein kinases, cyclins and growth factors – stages of meiosis

Unit V **(18 hours)**

Cancer: Growth properties of cancer cells; tumour suppressor genes: RB and p53; Oncogenes: proteins encoded by oncogenes; viral oncogenes; strategies for combating cancer

Apoptosis: events of apoptosis; role of caspases; regulation of apoptosis by Bcl-2 family proteins and signalling pathways of apoptosis

Textbook

1. Cell and Molecular Biology, 4th Edition, 2020, Rastogi, S.C., New Age International Pvt. Ltd., New Delhi
2. Cell and Molecular Biology, 5th Edition, 2017, Gupta, P.K., Rastogi Publications, Meerut

Reference books

1. Karp's Cell and Molecular Biology: Concepts and Experiments, 9th Edition, 2020, Janet Iwasa and Wallace Marshall, John Wiley & Sons Inc
2. The Cell: A Molecular Approach, 8th Edition, 2019, Geoffrey M. Cooper, Oxford University Press
3. Becker's World of the Cell, 8th Edition, 2012, Jeff Hardin, Gregory Bertoni and Lewis J. Kleinsmith, Pearson Benjamin Cummings
4. Essential Cell Biology, 5th Edition, 2019, Bruce Alberts, Karen Hopkin, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, W. W. Norton & Company, Inc
5. Molecular Cell Biology, 8th Edition, 2016, Arnold Berk, Chris A. Kaiser, Harvey Lodish, Angelika Amon, Hidde Ploegh, Anthony Bretscher, Monty Krieger, and Kelsey C. Martin, Macmillan Learning

eResources

1. http://www.cellsalive.com/
2. https://www.biointeractive.org/classroom-resources/electron-transport-chain
3. https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/41/1083/et/L20200220060602024949.pdf
4. https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/41/1086/et/L23200220060602022828.pdf
5. https://ugcmoocs.inflibnet.ac.in/index.php/courses/moocs
6. https://www.ncbi.nlm.nih.gov/books/NBK9839/?depth=10
7. https://learninglink.oup.com/access/content/cooper8e-student-resources/cooper8e-chapter-11-video-1
8. https://learninglink.oup.com/access/content/cooper8e-student-resources/cooper8e-chapter-15-video-1
9. https://learninglink.oup.com/access/content/cooper8e-student-resources/cooper8e-chapter-16-video-3
10. https://learninglink.oup.com/access/content/cooper8e-student-resources/cooper8e-chapter-18-animation-4
11. https://www.biointeractive.org/classroom-resources/role-p53-cell-cycle
12. https://www.biointeractive.org/classroom-resources/eukaryotic-cell-cycle-and-cancer
13. https://www.biointeractive.org/classroom-resources/ubiquitin-and-proteasome

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Core 2: BIOCHEMISTRY

Contact hours per Semester – 90 hours **Credits: 4**
Contact hours per Week – 6 hours **Subject Code: P22ZYC12**

Learning Objectives:

- To acquire knowledge on chemical structure, functions and metabolic process of biomolecule in living system.
- To gain information about bioenergetics and high energy compounds

Course outcomes:

CO1-Define structure and types of chemical bonds in biomolecules
CO2- Identify the structural significance and metabolic process of biomolecules
CO3- List various biomolecules classification and their mechanism which enhance their bioactive reaction

CO4- Analyze biomolecule in biological system and relate deficiency disorders
CO5- Interpret lipid metabolism and their importance

Unit–I **(18 hours)**

Structure of atom and Chemical Bonds-Ionic bond, Covalent bond, Hydrogen bond, van der Waals force; Water-properties, Structure; pH and Buffer-acid and bases, Ionization of weak acid, Henderon-Hasselbalch equation, Bicarbonate and Phosphate buffers, acid-base balance of the body-buffer system of body fluids, respiratory mechanism, renal regulations, abnormalities of acid – base balance.

Unit –II **(18 hours)**

Bioenergetics – thermodynamics- First law of thermodynamics- Energy, Enthalpy; Second law of thermodynamics- Spontaneity and Disorder, Entropy, Measurement of Entropy; Free Energy-Gibbs Free energy, Free energy and work; Chemical Equilibria-Equilibrium constants, Standard free energy changes, coupled reactions; Biological Oxidation-Oxidation-Reduction, Electron transport chain; High Energy phosphate compounds.

Unit–III **(18 hours)**

Carbohydrates–classification, structure, properties and functions–glucose, fructose, galactose, lactose, maltose, sucrose, starch, glycogen and cellulose; Carbohydrates metabolism-Glycolyis, Citric acid cycle, Gluconeogenesis, Glycogenesis, Glycogenolysis, HMP shunt; Glycogen storage diseases; Hormonal regulation of blood sugar-glucose tolerance test.

Unit–IV **(18 hours)**

Aminoacid– Classification, Structure, properties of aminoacids, amphoteric nature, isoelectric point, isoelectric pH and zwitter ion; protein – classification and structural organization of proteins- Primary, Secondary, Tertiary and Quaternary; biochemistry and biosynthesis of insulin, haemoglobin, Purine and pyrimidine bases; Enzymes- Nomenclature, Classification, Mechanism of enzyme action – types of inhibition, Factors affecting enzyme activity; Coenzymes and Isoenzymes.

Unit–V **(18 hours)**

Lipids-Classification, Structure and properties of triglyceride, phospholipid, glycolipid, derived lipids-steroids and cholesterol, terpenes, prostaglandins, and carotenoids; Lipid metabolism- Beta Oxidation of fatty acids; Ketone bodies-structure, ketogenesis, utilization of ketone bodies, over production of ketone bodies, regulation of ketogenesis; Biosynthesis of cholesterol; Vitamins – Structure and functions of ascorbic acid, thiamine, riboflavin, niacin and cyanocobalamine.

Text books :

1. J.L. Jain, "Fundamentals of Biochemistry", S. Chand Company Ltd., 1997.
2. U.Satyanarayana and U.Chakrapani, "Biochemistry", Books and Allied (P) Ltd, Kolkata, India 2017.
3. Ambika Shanmugam, "Fundamentals of Biochemistry for Medical student, Seventh Edition, Nagaraj and Company Private Ltd., Chennai, 2008.
4. S.C. Rastogi, "Biochemistry", Third Edition, Tat McGraw Hill Education Private Ltd., New Delhi, 2010.

Reference books:

1. Glasstone, "Thermodynamic for Chemists", Litton Educational Publishing, Inc., New York, 1947.
2. Mukhtar Ahmad, "Text Book of Modern Biochemistry", Oxford and IBH publishing Co. Pvt Ltd., 1995.
3. M.M.Cox and D.L.Nelon, "Lehninger Principles of Biochemistry", Fifth Edition, W.H. Freeman and Company, New York, 2010.
4. R.K.Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, "Harper's Biochemistry",25th Edition, McGraw Hill, 2000.
5. D.Voet and J.G. Voet, "Biochemistry", Second Edition, John Wiley and Sons, Inc., 1995.
6. T.M.Delvin, " Text Book of Biochemistry with Clinical Correlations", Fourth Edition, John Wiley and Sons, Inc., 1997.
7. D.T. Haynie, "Biological Thermodynamics", Second Edition, Cambridge University Press, 2008.
8. E.A. Newsholme and T.R. Leech, "Functional Biochemistry in Health and Disease", John Wiley and Sons Led., 2010.

e-Resources

1. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/353
2. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/141
3. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_pg/671
4. https://youtu.be/haO3ChM2wUs
5. https://youtu.be/mdb4YBS-Bu0
6. https://youtu.be/6Hv72iFjTlo
7. https://youtu.be/wBJ5LrasEmw
8. https://youtu.be/QHfFuVoPYUs
9. https://youtu.be/lOVskNjOLKo
10. https://youtu.be/s_zFlHzd1Yo
11. https://youtu.be/NUKu3LEEcYc
12. https://youtu.be/9QrCwFm_Vf4
13. https://youtu.be/fFtUuh3DRhc

Course Title: TECHNIQUES IN BIOLOGY	**Total hours:90**
Course Code: P22ZYC13	**Total Credit:4**

COURSE OUTCOME

Cos	COs Statements
CO1	Understanding the multiplication of desired genes using PCR techniques, DNA and protein sequencing, C – value paradox and various blotting techniques with their applications.
CO2	Describing the principle and applications of various microscopic techniques.
CO3	Understanding the separation techniques such as chromatography and centrifugation.
CO4	Explaining various Spectroscopic Techniques.

CO5	Applying radioisotope techniques in biology.

TECHNIQUES IN BIOLOGY

UNIT-I **(18 hours)**

Microscopic Techniques:

Principle and applications of Light and Phase contrast microscopes; Principle of Freeze Fracture and Freeze Etching Techniques; Basic theory and applications of Transmission Electron Microscope and Scanning Electron Microscope; Principle and applications of Fluorescence, Confocal and Atomic Force Microcopy.

UNIT-II **(18 hours)**

Separation Techniques: Basis and applications of thin layer chromatography, gel filtration, ion exchange, affinity, High Performance Liquid Chromatography (HPLC). Principle and applications of Polyacrylamide gel electrophoresis (PAGE) and AGE. Instrumentation of Centrifuges and their types: Differential and Density gradient centrifugation.

UNIT-III **(18 hours)**

Recombinant DNA Methods: The Polymerase Chain Reactions (PCR): The practical aspects of PCR- the primers and other components of PCR; principles and applications of PCR. Types of PCR: Reverse Transcriptase PCR (RT-PCR) and Multiplex PCR. DNA Sequencing: Chemical cleavage method Sanger's method. Automated DNA Sequencing. Principle and steps of Protein Sequencing. Genes and C – value paradox: DNA denaturation and renaturation. Principle and applications of nucleic acid hybridizations;

Blotting techniques: Principle and applications of Southern, Northern and Western blotting techniques.

UNIT-IV **(18 hours)**

Spectroscopic Techniques: Principle and applications of ultraviolet, visible, electron spin resonance (ESR) and nuclear magnetic resonance (NMR) spectroscopy; Molecular structure determination by X-ray diffraction; Principle and applications of mass spectroscopy (MS); Biological applications of Atomic absorption and plasma emission spectroscopy.

UNIT-V **(18 hours)**

Radioisotope Techniques: Nature of radioactivity; radioactive isotopes; detection and measurement of radioactivity: Biological applications of radioisotope techniques. Flow Cytometry: Instrumentation, Fluorescence-Activated Cell Sorting (FACS), Fluorescence Labels, Fluorescent Dyes and Applications.

TEXT BOOKS:

1. Dr. P. K. Bajpai, "Biological Instrumentation and Methodology (Tools & Techniques of Biology), S. Chand and Company, Second Edition, 2010.

UNIT	PAGE NO
UNIT I	126 – 133 203 - 240
UNIT II	21 - 49
UNIT III	159 - 190
UNIT IV	---------
UNIT V	134 - 145

2. Andreas Hofmann and Samuel Clokie, "Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology", Cambridge University Press, Eighth Edition, 2018.

UNIT	PAGE NO
UNIT I	73 – 176

UNIT II	381 – 420
UNIT III	196 – 209 424 – 452
UNIT IV	454 – 498 535 – 557
UNIT V	287 - 312 313 – 344

REFERENCE BOOKS:

1. Michael Wink, "An Introduction to Molecular Biotechnology", Wiley Blackwell, Second Edition, 2011.
2. Wilson K and Walker J, "Principles and Techniques of Practical Biochemistry", Cambridge University Press, Fourth Edition, 1994.
3. Braithwaite A and Smith F J, "Chromatographic Methods", Chapman Hall, London, Fourth Edition, 1985.
4. Plummer D T, "Practical Biochemistry", Tata McGraw Hill Publications, Third Edition, 1987.
5. Brown T A, "Gene Cloning and DNA Analysis: An Introduction'', Wiley Blackwell, Seventh Edition, 2016.

e-Resources

1. https://youtu.be/JmveVAYKylk
2. NPTEL - Module 3 PCR : https://nptel.ac.in/courses/102/103/102103013/
3. https://biocyclopedia.com/index/cell_biology_methods/freeze_fracture_and_freeze_etching.php
4. https://youtu.be/BbBK4T5Yr3M
5. https://my.eng.utah.edu/~lzang/images/Lecture_10_AFM.pdf
6. https://youtu.be/ZN7euA1fS4Y?t=105
7. https://youtu.be/i_6y6Z5UvwE
8. https://youtu.be/RqBAW-uFHK0
9. https://youtu.be/SQucmCTpdgg
10. https://youtu.be/ieEeFKrFBIg
11. https://youtu.be/rjuFrk0-AOw

ELECTIVE: AQUACULTURE

Contact hours per Week – 6 hours **Credits: 4**
Contact hours per Semester – 90 hours **Subject Code: P22ZYE11**

Course Outcome

CO1: To gain knowledge on site selection and construction of fish pond and various types of fish ponds.
CO2: To learn induced breeding technique of commercially important cultivable fishes
CO3: To understand the nutritional requirements of live and artificial fish feed.
CO4: To know the common fish diseases, treatment and control measures.
CO5: To study the types of fishing Crafts and gears and methods of fish preservation.

UNIT– I **(15 Hours)**

Scope of aquaculture - Status of aquaculture in India –- Types of culture - milk fishes –Site selection and Construction of ponds– types of ponds - soil and water quality–preparation and fertilization of fish pond- management – predator and weed control.
Shrimp farming: shrimp hatchery, processing and export

UNIT– II **(20 Hours)**

cultivable fresh water fishes (*Cyprinus carpio,* Catla, Rohu) and marine

species. Barracuda (Sheela fish)-Whiteleg shrimp (*Litopenaeus vannamei)*
Fish Breeding– bundh breeding– Hyphophysation; Principle, procedure and advantages- types of synthetic hormones – seed transport–
Fish feed - Types: live feed culture– phytoplankton (diatoms) Zooplanktons (Rotifers) Artemia, Chironomous larvae
Formulations and preparation of formulated fish feed

UNIT– III **(20 Hours)**

Ornamental fish culture – Introduction– Common ornamental fishes (sword tail, angel fish, zebra fish, black molly, guppy, common gold fish, clown fish)- construction of fish tank (base covering and stocking of fish), aquatic ornamental plants - Breeding methods of Commercially important ornamental fishes (Gold fish, Guppy, Molly).

UNIT– IV **(20 Hours)**

Composite fish culture- Animal husbandry cum aquaculture, agriculture cum aquaculture- Ectoparasite (Argulus and Lernea), Endoparasite (Ligulosis), Bacterial (Gill rot, Erthroderma) Viral (EUS, Viral Haemorrhagic Septicaemia) and fungal (Gill rot, Saprolegniasis) diseases and their control measures.

UNIT– V **(15 Hours)**

Fishing crafts (Coracle, Kattumaram, Trawler, Dredgers) and gears (Trawl nets, Cast nets, Gill nets) and hook and line– fish preservation– principles and methods– marketing– Economics of aquaculture.

Text books:

1. N. Arumugam, "Aquaculture", Saras Publication, Nagercoil. 2010.
2. G. Santhanakumar and A.M. Selvaraj, "Concepts of Aquaculture", Meenam Publications, Nagercoil. 2005.

Reference books:

1. V.G. Jingaran, "Fish and Fisheries of India", Hindustan publishing Co., New Delhi, 1997.
2. S.C. Agarwal, "A hand book of fish farming", Narandendra publishing house, Delhi, 1994.
3. S.B. Zade, C. Khune, S.R. Site and R.V. Jigare, "Principles of Aquaculture", Himalaya Publishing House, Mumbai, 2011.
4. S.K. Gupta and P.C. Gupta, "Principles of Aquaculture", S. Chand publications – New Delhi, 1990.

LAB: CELL AND MOLECULAR BIOLOGY

CORE: 4

Contact hours per Week – 3 hours **Credits: 3**

Contact hours per Semester – 45 hours **Subject Code: P22ZYP11**

Course outcome:

CO1: Know how to work with Microscope
CO2: Acquires the knowledge of size of the cells
CO3: Expertise in preparing chromosomes in a slide
CO4: Performs the Isolation the cell organelles

1. Bright field and Phase contrast microscopes – Principle, operations and applications
2. Measurement of cell size using micrometer
3. Isolation of mitochondria from goat liver by differential centrifugation
4. Observation of mitosis using the preparation of chromosomes from onion root tip
5. Observation of meiosis using the preparation of chromosomes from grasshopper testis – Demonstration only
6. Observation of giant chromosome in the salivary gland of Chironomous larvae

7. Preparation of cellular constituents in the blood smear of human, fish and haemolymph of insect
8. Isolation of DNA from animal cell – Determination of tm value
9. Histochemical localization of Carbohydrates, Proteins, Lipids and Nucleic acids
10. Microtechnique: Fixation, Dehydration, Infiltration, Embedding, Sectioning and Staining.

LAB: BIOCHEMISTRY

CORE: 5

Contact hours per Week – 3 hours **Credits: 3**

Contact hours per Semester – 45 hours **Subject Code: P22ZYP12**

Course outcome:

CO1: Student knows how to prepare Buffer
CO2: Can estimate the Enzyme activity
CO3: Expertise in handling the Colorimeter instrument
CO4: Acquires the knowledge of separating pigments and proteins

1. Preparation of Buffer
2. Titration curve – Estimation of pKa value of a Weak acid by pH meter
3. Effect of temperature on Salivary amylase activity
4. Determination of Km and Vmax value of Salivary amylase
5. Verification of Beer – Lambert law using $CuSO_4$
6. Estimation of Carbohydrate – Anthrone method
7. Estimation of Proteins –Lowry method
8. Determination of iodine number of an edible oil
9. Separation of Pigments by Thin Layer Chromatography
10. Separation of protein by SDS-PAGE

SECOND SEMESTER

CORE 6 - MOLECULAR GENETICS

Contact hours per Week – 6 hours *Credits: 4*

Contact hours per Semester – 90 hours *Subject Code:* **P22ZYC21**

Course outcome:

CO1: Predict the genotypic and phenotypic ratios in the meiotic products
CO2: Perform a quantitative analysis of the progeny of a dihybrid testcross to assess whether the two genes are linked on the same chromosome
CO3: Illustrate the features of DNA replication and the machineries that contribute to its speed and accuracy
CO4: Compare and contrast the critical roles played by different kinds of RNA in protein synthesis
CO5: Differentiate the molecular mechanisms of gene regulation in eukaryotes and bacteria
CO6: Describe human genetic diseases that are caused by genetic changes

Unit – I **(18 hours)**

Mendel's postulates: Law of segregation and law of independent assortment; Molecular basis of Mendelian inheritance pattern: alleles at the molecular level – Chromosome theory of heredity: Gene mapping by linkage analysis; Three-point test cross; Linkage and Crossing over; Sex linked genes in

human; Sex chromosomes and Sex determination; Dosage compensation of X linked genes – Genetic transfer in bacteria – Evolutionary significance of recombination

Unit – II **(18 hours)**

Changes in chromosome structure: deletion and duplication; rearrangements of chromosome structure: inversions, translocations, compound chromosomes and Robertsonian translocations.
Variation in chromosome number: Aneuploidy, Polyploidy; types of polyploidy; evolutionary significance of polyploidy; meiotic nondisjunction: Monosomy and Trisomy in human.
Types and causes of mutation – molecular basis of mutation.
DNA repair mechanisms: photo reactivation; excision repair; recombination repair; SOS repair.

Unit III **(18 hours)**

Experimental evidences for DNA as genetic material; Physical properties of DNA; Chargaff's rule; alternate forms of DNA; DNA Replication in Prokaryotes and Eukaryotes; models of replication; Enzymology of DNA replication; Proof reading activity of Replication apparatus; Role of DNA polymerase, helicases, ligase, and topoisomerases in Replication.

Unit – IV **(18 hours)**

Transcription in Prokaryotes and Eukaryotes; types of RNA.
Post transcriptional modifications in eukaryotes: Capping, poly adenylation, splicing of introns and RNA editing; Role of snRNPs in pre-mRNA splicing.
Genetic code: Properties of genetic code; deciphering the code.
Translation: functional role of tRNA and ribosomes in protein synthesis.

Unit – V **(18 hours)**

Gene regulation in prokaryotes: Induction and suppression of *lac* operon in *E. coli*; Attenuation of *trp* operon; Positive and Negative control of *ara* operon; post translational regulatory mechanisms.
Gene regulation in eukaryotes; alternate splicing of RNA; histone modification; heat shock genes; cytoplasmic control of mRNA stability; enhancers and silencers; transcription factors; RNA interference by miRNA and siRNA; activation and inactivation of whole chromosomes.

Textbook

1. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, Darrell Killian, Concepts of Genetics, Pearson Education, 11th Edition, 2019
2. Veer Bala Rastogi, Genetics, Medtech Publishers, 4th Edition, 2019

Reference books

1. D. Peter Snustad and Michael J. Simmons, Principles of Genetics, John Wiley & Sons Inc, 7th Edition, 2016
2. Anthony J.F. Griffiths, Susan R. Wessler, Sean B. Carroll and John Doebley, Introduction to Genetic Analysis, W.H. Freeman & Company, 11th Edition, 2015,
3. Robert J. Brooker, Genetics: Analysis and Principles, McGraw-Hill Education, 6th Edition, 2018
4. Jocelyn Krebs, Stephen Kilpatrick, and Elliott Goldstein, Lewin's Genes XI, Jones & Bartlett Learning, 2014
5. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Molecular Biology of the Gene, Pearson Education Inc, 7th Edition, 2013

e-Resources

1. http://opengenetics.net/open_genetics.html
2. https://www2.le.ac.uk/projects/oer/oers/genetics/oers/Patterns%20of%20inheritance/Patterns%20of%20inheritance-TRF.pdf

3. https://www2.le.ac.uk/projects/oer/oers/genetics/oers/ger/ger.pdf
4. https://www2.le.ac.uk/projects/oer/oers/genetics/oers/DNA%20Genes%20and%20chromosomes/DNA%20Genes%20and%20chromosomes-TRF.pdf
5. https://www.youtube.com/watch?v=iJGY1boNOdg (Recombination in Bacteria)
6. https://www.youtube.com/watch?v=IJQv1H-2IoI (Splicing mechanism and its importance)
7. https://www.youtube.com/watch?v=CaCq4gglw0g (Lac Operon concept)
8. https://www.youtube.com/watch?v=Wv9csJGYLmU (Heat shock protein)
9. https://www.youtube.com/watch?v=-AhKTeekXYg (Trp attenuation)
10. https://www.youtube.com/watch?v=TAZgW6222fs (Gene regulation in Prokaryotes vs Eukaryotes).

Course Title: ECOLOGY	**Total Hours: 90**
Course code: P22ZYC22	**Total Credits: 4**

Course Outcomes:

Cos	CO Statement
CO1	To study the concept and components of ecosystem
CO2	To understand the characteristics of population and to learn its interaction with environment
CO3	To sensitize the students on the careful utilization of environmental resources
CO4	To analyse the problems associated with mismanagement of resources
CO5	To create environment awareness among students

Unit – I **18 hours**

Ecosystem: concept and components; Light and temperature as limiting factors; trophic structure of ecosystem

Functions of ecosystem: productivity, energy flow: food chain, food web, trophic levels, and ecological pyramids.

Homeostasis - cybernetic nature; stability

Biogeochemical cycles; Carbon, Nitrogen, Sulphur, Phosphorus and water.

Unit – II **18 hours**

Population: characteristics, density, natality, mortality, survivorship curve, life tables; Biotic potential, growth curves, growth models, fluctuations, structure, concept of r and k selection; Life history traits and tactics; population regulation: density dependent and density independent factors; Inter and Intraspecific interactions: parasitism, predation, competition, commensalism, mutualism.

Unit – III **18 hours**

Community: Characteristics and structure

Physical structure: growth forms; stratification: vertical, horizontal and temporal stratification, seasonality, periodicity

Biological structure: species abundance, species diversity, species dominance, diversity indices ; factors regulating species diversity

Ecological niche: types, guild, ecotone and edge effect; concept of climax; ecological succession; ecological indicators

Unit- IV **18 hours**

Resource ecology- concept and classification; Renewable resources: solar energy, hydropower, wind, biomass, biofuels, wave and tidal energy, geothermal energy
Non-renewable resources: fossil fuels: coal, oil, natural gas, nuclear fuels
Biodiversity: types; importance and threats to biodiversity; Endangered species; biodiversity conservation - *in situ, ex situ* and *in vitro* – impact of alien/ invasive/ non-indigenous species on biodiversity

Unit -V **18 hours**

Climate change: Problems of climate change: global warming; melting of glaciers and polar icecaps; sea level rise
Hazards of climate change: forest fire; heat waves; drought; floods; cyclones, hurricanes and typhoons; loss of biodiversity and impact on flora and fauna; health effects; food security; climate refugees
Role of bioindicators and bioaccumulators in environmental monitoring, GIS, environmental organizations in India, remote sensing and its applications; Role of government, media in environmental education.

Text books:

1. T.K Saha," Ecology and Environmental Biology", Books and Allied (P) Ltd, Kolkata, India. 2013.
2. N.S Subrahmanyam, and Sambamurty, "Ecology", Narosa Publshing house, New Delhi, India, 2000.

Reference books

1. H.D Kumar," Modern Concepts of Ecology", 8th Edition, Vikas Publishing House Pvt. Ltd, 1997.
2. E.P. Odum, "Basic Ecology", Saunders College Publishing,1983.
3. Richard T. Wright, Dorothy F. Boorse, Environmental Science Toward a Sustainable Future, 11th Edition, Pearson Education Inc., 2011
4. E.J. Koramandy, "Concepts of Ecology", 3rd Edition, Prentice Hall of India Pvt. Ltd,1986.
5. K.C. Agarwal, Biodiversity, Agro Botanical Publishers (India), 1996
6. M.C Dash and S.P Dash, "Fundamentals of Ecology",Tata McGraw Hill Education Private Ltd., New Delhi, 2010.
7. MN William, Biodiversity, CBS Publishers & Distributors, 2019
8. Suruchi Singh, Pradeep Singh, S. Rangabashiyam, K.K. Srivastava, Global Climate Change, Elsevier Inc., 2021

e-Resources:

1. https://nptel.ac.in/content/storage2/courses/122103039/pdf/mod6.pdf
2. https://nptel.ac.in/content/storage2/courses/122106030/Pdfs/1_1.pdf
3. https://nptel.ac.in/content/storage2/courses/120108004/module1/lecture1.pdf
4. https://nptel.ac.in/content/storage2/courses/103107084/module1/lecture1/lecture1.pdf
5. https://nptel.ac.in/courses/105/108/105108077/
6. https://www.ugc.ac.in/oldpdf/modelcurriculum/chapter4.pdf
7. https://youtu.be/zQi3C_eZkLs
8. https://youtu.be/mpHZWYpKDJg

CORE 8 - BIOSTATISTICS AND BIOINFORMATICS

Contact hours per Week – 6 hours **Credits: 4**
Contact hours per Semester – 90 hours **Subject Code: P22ZYC23**

Course Outcomes

Cos	CO Statement
CO 1	Learners can recognize the definition of statistics, its subject and its relationship with the biological sciences.
CO 2	Learners can identify distribution form relating to the variable/variables. recognize normal distribution and interpret data via normal distribution.
CO 3	Learners can calculate and interpret measures of central tendency and variability in statistical data and compare different population sample using ANOVA
CO 4	Learners can familiarise the basics of bioinformatic databases and the types of Bioinformatic data.
CO 5	Learners can understand the nucleotide and protein sequence databases.

Unit – I **(18 hours)**

Biostatistics: Definition, Terms, Applications, Role of biostatistics in modern research, Limitations of Statistical Methods. *Types of data:* Primary, secondary, qualitative, quantitative, Scales of measurement of statistical data. – Collection of data: Methods of Collection: census and sampling techniques- Classification and Tabulation of data: Data Summarisation and Class intervals, Preparation of Class intervals and Tally marks - Frequency; Frequency distribution, types and preparation of frequency table - Representation of data: Bar diagram, Pie diagram, Histograms, Frequency polygon, Frequency curve: Skewness, Kurtosis, Ogive

Unit – II **(18 hours)**

Measures of Central tendency: Mean, Median, Mode, Quartiles and Percentiles – problems.
Measures of variability or dispersion: Types of Variability and Measures of dispersion, Range, Mean Deviation, Standard Deviation, Standard Error, Quartile deviation, Variance and Coefficient of variance – problems
Probability: Types and rules of probability; conditional probability
Probability Distribution: Normal, Binomial and Poisson distributions - simple problems.

Unit – III **(18 hours)**

Inferential statistics - Statistical estimation; Types, methods and Applications - Testing of statistical hypothesis
Correlation analysis: Types and measure of correlation - Karl Pearson's coefficient of correlation (simple problems) and Spearman's rank correlation.
Regression analysis: Methods for Regression: Simple and multiple regression; Difference between regression and correlation analysis.
Students t-test, chi square test and one way ANOVA - simple problems.

Unit – IV **(18 hours)**

Bioinformatics - Introduction - applications and research, bioinformatics in India, bioinformatics Databases in biology: Characteristics of Bioinformatics databases, Classification of databases (based on the types of data, maintainer status, technical design, data source and data access) Primary nucleotide sequence databases: GenBank, EMBL, and DDBJ, searching and retrieving from primary sequence data bases.
Sequence alignment – pairwise and multiple sequence

Unit – V **(18 hours)**

Secondary nucleotide sequence databases: UniGene, STACK, Ribosomal database project, HIV sequence database, Eukaryotic promoter database and REBASE. Protein sequence databases: UniProt,

PIR, Swiss-Prot and TrEMBL – Structure databases: PDB, secondary and specialized protein sequence databases. Other databases; Enzyme databases, Pathways databases and Diseases databases.

Text books:

Unit I - Veer Bala Rastogi, "Biostatistics", MedTech, New Delhi. 3rd Edition/ 2015. Page No. 6– 82.
Unit II - Veer Bala Rastogi, "Biostatistics", MedTech, New Delhi. 3rd Edition/ 2015. Page No. 91– 161, 205– 234.
Unit III - Veer Bala Rastogi, "Biostatistics", MedTech, New Delhi. 3rd Edition/ 2015. Page No. 239– 242, 308-320, 337– 368.
Unit IV - Orpita Bosu, Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University Press, New Delhi. 2010. Page No. 8 – 11, 21- 37.
Unit V - Orpita Bosu, Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University Press, New Delhi. 2010. Page No. 44 – 81, 106 - 139.

Reference books:

1. Bailey, N.T.J, "Statistical methods in Biology", Hodder and Stongtton, London. 1979.
2. Campell, R.C, "Statistics for biologists", Blacker and Sons Publishers, Bombay. 1981.
3. Gupta, C.B. and Gupta, V, "Statistical methods", Ikas Publishing House, New Delhi. 1992.
4. Zar, J.H, "Biostatistical Analysis", Pearson Education, Delhi. 1999.5. Ignacimuthu S, "Basic Bioinformatics", Narosa Publishing House, 2013.
6. Rajadurai M, "Bioinformatics – A Practical Approach", PBS Book enterprises, Chennai. 2010.
7. Dan E. Krane and Michael L. Raymer, "Fundamental Concepts of Bioinformatics", Pearson Education Pte Ltd, New Delhi, 2003.
8. Arthur M. Lesk, "Introduction to Bioinformatics", Oxford University Press, New Delhi 2014.

E - Resources

1. https://www.youtube.com/watch?v=cKQaKy6fjAQ&feature=emb_imp_woyt
2. https://youtu.be/p7EN4NcTjnM
3. https://youtu.be/GqPCE6hKbUw
4. https://youtu.be/6MEdP4zMLuQ
5. https://youtu.be/IaBQBiOID1c
6. https://youtu.be/PETpnhcm3-Y
7. https://youtu.be/quRYt4d4rDA
8. https://youtu.be/qQw0MJ7L3tI

NME - ECONOMIC ZOOLOGY

Contact hours per week– 6 hours **Credits: 4**
Contact hours per Semester– 90 **Subject Code: P22ZYN21**

Course Outcome:

CO1: Applying studied information to have knowledge on common cattle breeds and their management, milk and milk products.
CO2: Understanding the knowledge of fowl breeds and their management, nutritive and economic value of chick and egg.
CO3: To inculcate knowledge on common ornamental fishes, aquarium setup, breeding, diseases and their treatment.
CO4: To satisfy the learners with modern techniques of silkworm and honeybee rearing with economic values.
CO5: To study the morphology of earthworm, production method of vermicompost with applications.

Unit – I **(18 hours)**

Dairy farming: Common cattle breeds- Cow (Jersey), Buffalo (Murrah) and Goat (Jamunabhari), Management of a model dairy farm- Livestock diseases- Foot and mouth disease, udder disease- Nutritive value of milk-milk products- Economics.

Unit – II **(18 hours)**

Poultry: Breeds of fowl- Sexing of one-day old chick- Rearing and management of Broilers and Layers- Nutritive value of chick and egg– disease control (Ranikhet, Coryza, fowl pox)– Economics.

Unit – III **(18 hours)**

Ornamental fish culture– Introduction – General characters of black molly, Guppy, common gold fish– construction of fish tank (base covering, plant and fresh water set up)– water quality management– types of feed and feeding methods– Breeding of ornamental fishes (Guppy, Gold fish)– fish disease (White spot, gill rot) and treatment– Economics.

Unit – IV **(18 hours)**

Sericulture – Mulberry plant - Morphology of silkworm *Bombyx mori*– Silkworm rearing– Marketing of cocoons– Economics. Apiculture– types of honeybees - Methods of honeybee rearing –Nutritive and medicinal values of honey-Economics.

Unit – V **(18 hours)**

Vermiculture–Introduction– General morphology of earthworm– Cultivable species – *Eisenia foetida* and *Eudrilus eugeniae*- Steps involved in Vermicomposting (bedding, layering, and watering)– Method of harvesting– Application of vermicompost and vermi wash- Economics.

- **Field visit- Dairy farm, Poultry farm, Ornamental fish farm, Silkworm rearing stations, Vermicompost production unit.**

Text books:

1. N. Arumugam, Applied Zoology, Saras Publications, Nagercoil. 2017.

Reference Books:

1. G.C. Banerjee, Animal husbandry, Oxford and IBH Publishing Co. 1998.
2. M.R. Gnanamani, Modern aspects of commercial poultry keeping, 9th edition, Giri Publications, 2003.
3. David Kingston *et al.,* Guidelines of ornamental fish culture, Veterinary University Training and Research Centre (Fisheries). 2006
4. G. Ganga and J. Sulochana Chetty, An introduction to sericulture, Oxford IBH Publishers, New Delhi. 1991.
5. S.A. Ismail, Vermicology, Orient Longman Ltd. 1997.

E-Resources

1. http://www.iaszoology.com/insect/
2. https://www.studyandscore.com/study-material/economic-zoology
3. https://www.slideshare.net/atulthakur007/economic-zoology
4. https://onlinecourses.swayam2.ac.in/cec20_ge23/preview
5. https://www.assignmentpoint.com/science/zoology/assignment-on-economic-zoology.html

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CORE 9 - LAB: MOLECULAR GENETICS

Contact hours per Week – 3 hours **Credits: 3**
Contact hours per Semester – 45 hours **Subject Code: P22ZYP21**

Course outcome:

CO1: Understand the practical implications of Mendel's Laws
CO2: Can estimate the Enzyme activity
CO3: Chart out the Pedigree analysis of any family
CO4: Acquires the knowledge of statistical applications of genetics experiments

1. Study on Law of segregation using beads.
2. Study on Law of independent assortment using coins/ beads.
3. Study on Probability by coin tossing.
4. Pedigree analysis for any two of the simple Mendelian traits.
5. Chromosomal disorders in human – Down's, Turner's and Klinefelter's syndrome. (Book Plates)
6. Microscopic observation of mutant phenotypes of *Drosophila.*
7. Study of bacterial survival against UV irradiation and mutagenesis.
8. Correlation analysis– Height and Weight of students- length and width of Polyalthia leaves.

Core-10: LAB: ECOLOGY

Course Title: LAB: Ecology	**Total Hours: 45**
Course code: P22ZYP22	**Total Credits: 3**

Course outcome:

CO1: Student able to estimate the Primary productivity
CO2: Critically analyze the Industrial effluents
CO3: Expertise in estimating the soil organic matter
CO4: Transforms the practical laboratory experience to the field through study tour

1. Estimation of primary productivity of aquatic macrophytes– Light and Dark bottle method
2. Estimation of primary productivity of terrestrial plants – Harvest method
3. Estimation of primary productivity of terrestrial plants – Chlorophyll content method
4. Estimation of CO_2 in the sewage water sample.
5. Analysis of industrial effluents – Total and dissolved solids
6. Analysis of industrial effluents – Biological Oxygen Demand (BOD)
7. Analysis of industrial effluents – Chemical Oxygen Demand (COD)
8. Estimation of soil organic matter
9. Estimation of dust pollution in urban locality – Time course kinetics of deposition of dust

A study tour of minimum 3 days is compulsory visit to wildlife sanctuaries, zoological parks, biosphere reserves etc. during the tenure of the programme. A detailed report of the study tour specifying the places and institutions visited, date and time of visit, details of observations made etc. must be submitted by each student in "hand written" mode for evaluation during the day of practical examination. The study tour report is compulsory for each student appearing for practical examination.

Course Name : Master of Science
Discipline : Zoology
CHOICE BASED CREDIT SYSTEM
(For those who join in June 2018 and after)
COURSE SCHEME:

Semester	Part	Subject	Hours	Credit	Int + Ext =Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject code	Revised / New / No Change / Interchanged & Percentage of revision
III	Core – 11	Immunology	6	4	40+60=100			✔		✓			✓			✓	P19ZYC31	Revised / 20%
	Core – 12	Developmental Biology	6	4	40+60=100			✔					✓			✓	P19ZYC32	Interchanged / 95 %
	Core – 13	Evolution	6	4	40+60=100			✔					✓			✓	P19ZYC33	Revised / 95%
	Elective – 2	Research Methodology	6	5	40+60=100			✔		✓			✓			✓	P19ZYE31	New / 100 %
	Core – 14	LAB: Immunology	3	3	40+60=100			✔								✓	P19ZYP31	Revised / 20%
	Core – 15	LAB: Developmental Biology	3	3	40+60=100			✔								✓	P19ZYP32	Revised / 60%
IV	Core – 16	Microbiology	6	4	40+60=100			✔		✓			✓		✓		P19ZYC41	Interchanged / 5 %
	Core – 17	Animal Physiology	6	4	40+60=100			✔					✓			✓	P19ZYC42	Revised / 55%
	Core – 18	Biotechnology	6	4	40+60=100			✔					✓		✓		P19ZYC43	No Change
		Project	6	5	50+50=100			✔					✓			✓	P19ZY4PV	New / 100 %
	Core – 19	LAB: Microbiology	3	3	40+60=100			✔							✓		P19ZYP41	Revised / 5%
	Core – 20	LAB: Animal Physiology	3	3	40+60=100			✔								✓	P19ZYP42	Revised / 30%

SEMESTER: III
IMMUNOLOGY

CORE: 11
Contact hours per Week – 6 hours **CREDITS: 4**
Contact hours per Semester – 90 hours **Subject Code:** P19ZYC31

Course Outcome:
CO 1: To acquire an overall knowledge of immune system.
CO 2: To familiarize the mechanism involved in humoral immune system.
CO 3: To comprehend the mechanism of cell mediated immunity.
CO 4: To understand basics of replacement therapies and cancer immunotherapy.
CO 5: To study the impact of immune cells in human diseases and importance of vaccines.

UNIT – I
Basic concepts of Immunology [15 Hours]
Historical perspectives: Louis Pasteur, Edward Jenner- types of Immunity– Acquired and Innate– Haematopoiesis: Lymphoid lineage– T, B cells and their types, Null cells- Myeloid lineage: Neutrophil, Eosinophil, Basophil, Mast cell, mononuclear cell and Dendritic cell- Primary Lymphoid organs: Structure and functions of Bone marrow, Bursa of Fabricius and Thymus- Secondary Lymphoid organs: Structure and functions of Spleen, Lymph node, MALT, GALT.

UNIT-II
Humoral Immune response [20 Hours]
Primary and Secondary immune response: B cell generation, activation and differentiation, expression of Immunoglobin gene- Structure, biological properties and functions of IgG, IgM, IgA, IgD and IgE – Properties of antigen- Complement: Classical and Alternate pathways- Antigen-Antibody interaction: Affinity, Avidity, Cross reactivity, Precipitation, Agglutination– Immunotechniques: Radioimmunoassay, ELISA, Western Blotting and Flow Cytometry.

UNIT –III
Cell Mediated Immunity [20 Hours]
T cell generation, activation and differentiation- Structure of T-cell receptor (TCR)- Expression of TCR genes- MHC polymorphism (Class I and Class II)– Structure of HLA Serological typing of HLA- Antigen processing and presentation (Cytosolic and Endocytic pathways)– Cytokines: Types and functions.

UNIT – IV (15 Hours)
Transplantation & Tumour Immunology
Transplantation: Types of graft- mechanism of graft rejection- immune suppressive therapy- Types of cancer, carcinogens, Oncogenes and Cancer induction, tumour antigen, immune response to tumour, Cancer immunotherapy.

UNIT – V (20 Hours)
Human diseases, Immunity and Vaccines
Immune evasion by pathogens - Immunodeficiency diseases: AIDS, SCID, Brutons disease, Digeorge syndrome - Hypersensitivity reactions: Type I, Type II, Type III and Type IV – Autoimmunity: Myasthenia gravis, Rheumatoid arthritis. Vaccine: Whole organism vaccine,

Purified macromolecular vaccine, Recombinant vector vaccine, DNA vaccine, Synthetic peptide vaccine.

Text Book

1. Owen, Punt, Stranford. Kuby Immunology 4th edition, New York, W.H. Freeman and Company. 2013.
2. Eli Benjamini, Text Book on Immunology, A short course, 3rd edition. UK, Blackwell Science,1996.

Reference Books

1. Roitt I.M., Essential Immunology, 9th edition, UK, Blackwell Science, 1994.
2. Janeway, travers, Walport and Shlomchik, Immunobiology – The Immune system in health and disease 6th Edition, NewYork, USA. 2005
3. A.K. Chakravarthy, Immunology, New Delhi. Tata McGraw Hill. 2000
4. James.T. Barrett , Text Book of Immunology 5th edition, New Delhi, IE International 1998.

DEVELOPMENTAL BIOLOGY

Contact hours per week : 6 hours
Contact hours per semester : 90 hours

Core Paper
Semester: III **Subject Code:** P19ZYC32

Course Outcome:

Upon completion of this course, the students will be able to

CO 1: Recognize the formation and maturation of germ cells in human
CO 2: Paraphrase the molecular changes that occur in an egg following the fusion of gametes
CO 3: Demonstrate the development of organs from germinal layers
CO 4: Distinguish between the causes of normal and abnormal development at genetic level
CO 5: Associate the role of hormones in ontogenetic development of insects and amphibians

Unit I **(18 Hours)**

Gametogenesis

Historical review of embryology– phases of ontogenetic development in metazoa– Spermatogenesis in human– meiosis– spermiogenesis– ultrastructure of spermatozoa– gene function in spermatogenesis– mammalian sperm maturation– male accessory sex glands in mammals– Oogenesis: growth of oocyte– oocyte-accessory cell interactions during oogenesis – vitellogenesis – types of egg– gene expression during oogenesis– organization of the egg– egg envelopes– maturation of egg– hormonal control of oogenesis in human.

Unit II **(18 Hours)**

Fertilization

External fertilization and activation of egg metabolism in sea urchin– acrosomal reaction and fusion of genetic material in mammalian egg – cortical reaction– block to polyspermy– initiation of cleavage – types of cleavage– patterns of cleavage– role of yolk on cleavage – blastulation and gastrulation in amphibians– axis formation in Zebra fish– gene activity during gastrulation– Determination of primary organ rudiments– inductive tissue interactions– primary embryonic induction– formation and functions of organizer.

Unit III **(18 Hours)**

Organogenesis

Ectodermal derivatives: development of Brain and Eye in Chick– differentiation of lens and cornea– Mesodermal derivatives: development of Heart and Kidney in Chick– formation of blood vessels– Endodermal derivatives: development of digestive tube and respiratory tube– extra embryonic membranes in birds– placentation in mammals– types and significance.

Unit IV **(18 Hours)**

Morphogenesis

Cytodifferentiation and chemodifferentiation– mechanisms of differential gene expression in development– differential RNA processing– control of gene expression at the level of translation– Homeotic genes and Hox genes- Genetic errors of human development – Teratogenesis: teratogenic agents– endocrine disruptors.

Unit V **(18 Hours)**

Postembryonic developments

Amphibian metamorphosis: morphological changes– physiological and biochemical changes – tissue reactivity– hormonal control – Insect metamorphosis: imaginal discs – hormonal control – molecular biology of 20-hydroxy ecdysone.

Regeneration– regenerative ability in various animals– biochemical changes– stem cell mediated regeneration in Planaria– epimorphic limb regeneration in Salamander– compensatory regeneration in the Mammalian liver– polarity and gradients in regeneration.

Text books:

1. Balinsky, B.I.,*An Introduction to Embryology*, W.B. Saunders Company, Philadelphia (1981).
2. Verma, P.S., Agarwal V.K., *Chordate Embryology: Developmental Biology,* S. Chand Publications, New Delhi. (2014).

Reference books:

1. Browder, L.N., 1980, *Developmental Biology*, Saunders College, Philadelphia
2. Gilbert, S.F., 2014, *Developmental Biology*, 10th Edn., Sinauer Associates, Inc. Publishers, Sunderland
3. Slack J.M.W., 2012, *Essential Developmental Biology*, Wiley-Blackwell.
4. Wolpert L., 2002, *Principles of Development*, 2nd Edn., Oxford Univ. Press.
5. Beril N.J., 1986 *Developmental Biology*, Tata Mcgraw-Hill Publishing Ltd, New Delhi
6. Berry A.K., 2007, *An Introduction to Embryology*, Emkay Publications, New Delhi

EVOLUTION

CORE: 13

Contact hours per Week – 6 hours **CREDITS: 4**

Contact hours per Semester – 90 hours **Subject Code:** P19ZYC33

Course Outcome:

CO 1: To learn the origin of earth and process of evolution.

CO 2: Learn about all types of evolutionary processes with the background of genetics and Mimicry types and their role in evolution.

CO 3: To understand the mechanism of formation of new species.
CO 4: To understand the concept of micro, macro and Megaevolution.
CO 5: To study the socio-cultural aspects of human evolution.

UNIT– I **(18 hours)**

Theories of Evolution

Origin of life– Evidences for evolution from Taxonomy: domain concept of living Kingdom, Zoogeography, embryology, Physiology, biochemistry, palaeontology and molecular phylogeny: construction of phylogenetic trees using 16S rRNA gene sequences- Theories of evolution– Lamarckism, Darwinism and Mutation theory of De Vries.

UNIT – II **(18 hours)**

Sources of variability

Genetic basis of variation: mutation, recombination, hybridization and Polyploidy– neutralist hypothesis– Adaptive radiation: modification of forelimbs, Darwin finches- Mimicry: types and their role in evolution- Hardy-Weinberg equilibrium- Allele frequencies and Haplotype frequencies.

UNIT – III **(18 hours)**

Speciation

Species concepts: Morphological and Biological concepts– subspecies, Sibling species, Races, Rassenkreis, Clines and Demes, Modes of speciation: Allopatric, Parapatric and Sympatric speciation- Isolating mechanisms: Geographic and Reproductive isolation- pre-zygotic and post- zygotic isolating mechanisms- role of isolating mechanisms in speciation- Genetics of reproductive isolation.

UNIT – IV **(18 hours)**

Modes of Evolution

Origin of higher categories: Processes involved in Microevolution, Macroevolution and Megaevolution- modes of origin of higher taxa: mosaic mode– connecting link– quantum evolution– Simpson's adaptive grid– rates of evolution, punctuated equilibrium– Extinction and its causes.

UNIT – V **(18 hours)**

Human Evolution

Fossil records of human evolution: Recent findings in East and South Africa– Trends in human evolution– Ape- Hominoid transition- cultural evolution: Osteodentokerotic culture, Pebble tool culture, Paleolithic culture and Neolithic culture– evolution of Brain and language- Sociobiology: Selfish gene, Altruism and Kin selection- Future evolution.

Text Books:

1. Rastogi, V.B. Organic Evolution (Evolutionary Biology), 13th edition, Medtech, A division of Scientific International (2006).
2. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W. Evolution, Surjeet Publications, New Delhi (1971).

Reference Books:

1. Moody, P.A. Introduction to Evolution, Harper International. (1978)
2. Dodson, E.V. Evolution process and product, East West Press, New Delhi. (1960)
3. Bendall, D.D. Evolution from molecule to Man, Cambridge University Press. (1983)
4. Grese, M. Dimensions of Darwinism, Cambridge University Press. (1983)
5. Minkoff, E.C. Evolutionary Biology, Addison Wesley. (1984)
6. Montangu, Socio biology Examined, Oxford University Press. (1980)

7. Weiss, M.L. Mann, A.E. Human biology and behaviour– An Anthropological Perspective, 4th Edition, Little Brown &Co. (1985)
8. Strickberger, M.W. Evolution. Jones and Barlett publishers Inc., London. (1996))
9. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W., Evolution. Surjeet Publications and Co., New York. (1975)
10. Savage, J.M. Evolution. Amerind Publishing Co. Pvt. Ltd. New Delhi. (1976)
11. Paulamos Moody. Introduction to Evolution. Kalyani Publishers, Ludhiana, New Delhi. (1978)

RESEARCH METHODOLOGY

Contact hours per week : 6 hours
Contact hours per semester: 90 hours

Elective *Paper*

Semester: III **Subject Code:** P19ZYE31

Course Outcome:

CO 1: It makes the understanding of finding a problem, related data collection from sources and designing and executing the experiment.
CO 2: Identify various sources of information for literature review and data collection
CO 3: Critically analyze research methodologies identified in existing literature
CO 4: Emphasis knowledge to write a research report and thesis
CO 5: Analyze the data using statistical tools to interpret the result significantly

Unit I **(18 Hours)**

Initiation of the Research

Objectives of Research- Criteria of Good Research- Understanding Research and its goals- Critical thinking- Motivation in Research- Types of Research- Research Approaches- Essential steps in research- Identification and selection of research problem- Topic selection and Justification- Importance of Research- Research Process.

Unit II **(18 Hours)**

Research resources

Sources of information- Methods of literature collection- Online- world wide web- Technical papers, Review of literature, Monographs, abstract- Index card and reference card- search tools-citation indices- ethical and moral issues in research- Plagiarism- tools to avoid plagiarism- IPR- Copy right laws– Patent rights.

Unit III **(18 Hours)**

Research Report

Introduction- components of research report- significance of Report Writing- Different Steps in Writing Report- Layout of the Research Report- Types of Reports- Oral Presentation- Writing a Research paper for journals- Reputed journals- Impact factor- H-index- citation index - Precautions for Writing Research Reports.

Unit-IV **(18 Hours)**

Formatting Research report

Preparation and presentation of research paper- Margin- Paragraph indentations- spacing- alignment- fonts- Title page- Authors and addresses– abstract- key words- introduction- materials and methods- results- discussion- conclusion- acknowledgements- references- Tables and figures- numbering and captions, footnotes- Evaluation of research report.

Unit V **(18 Hours)**

Role of Computer in Research

Introduction– Data storage- Data analysis- Scientific simulations- Standard deviation, Standard Error, Correlation, Regression, t-test and ANOVA using EXCEL- SCOPUS and Web of Sciences.

Text books:

1. P. Saravanavel. Research Methodology. Patna: Kitab Mahal Agencies, Ashok Rajpath.1994.
2. N. Gurumani. Research methodology for Biological Sciences. Chennai: MJP Publishers.2006.

Reference Books:

1. C.R. Kothari. *Research Methodology-Methods and techniques* (Second revised edition). New Delhi: New Age International Publishers; 2004.
2. Ranjit Kumar. *Research Methodology-A step wise step guide for beginners* (Third edition). London: SAGE Publications Ltd; 2014.
3. Robert A. Day. *How to write and Publish a Scientific paper*. University City Science Centre, Philadelphia: ISI Press. 1979.
4. Anderson, A.H., Dursaton and Poole, M .*Thesis and Assignment Writing*.-Wiley Eastern, 1970.
5. Leedy, P.D. *Practical Research-Planning and Design* (8th edition). Pearson; 2005.

SEMESTER – III

LAB: IMMUNOLOGY

Core: 14 Subject Code: P19ZYP31 Credits:3

Contact hours per week – 3 hours

Contact hours per semester – 45 hours

1. Observation of lymphoid organs in Chick.
2. Study of histology of Thymus, Spleen, Lymph node and Bursa of Fabricius using permanent slides.
3. Preparation of single cell suspension (Chick/ Goat spleen).
4. Preparation of antigen (Chick/ Sheep blood).
5. Immunisation and Bleeding techniques in Rat (Photographs/ ICT tools).
6. Antigen and Antibody titration by WIDAL Test
7. Isolation of lymphocytes from the fish blood.
8. Observation of haemagglutination by blood grouping kit.
9. Determination of antigen-antibody reaction by Ouchterlony Double Diffusion technique.
10. Spotters: Primary immune response curve, Immunoglobulin G and A, Di- George syndrome and Well Plate.

LAB: DEVELOPMENTAL BIOLOGY

Contact hours per week : 3 hours

Core: 15 **Subject Code:** P19ZYP32

1. Morphology and histology of ovary – Grasshopper/ Cockroach and Fish.
2. Histological study of ovary of Frog and Rat/ Squirrel based on permanent slides.
3. Morphology and histology of testis – Grasshopper/ Cockroach and Fish.
4. Histological study of testis of Frog and Rat/ Squirrel based on permanent slides.

5. Sperm count from any domestic animal (Source of semen: Government artificial insemination centre)– Sperm motility in a fish / Tilapia fish/ Bull Sperm.
6. Study of developmental stages of chick through slides and whole mounts – 24 hrs, 48 hrs, 72 hrs and 96 hrs.
7. Embryonic development of the egg of Tilapia fish (demonstration only).
8. Effect of thyroxin/ retinoic acid/ proline/ pesticide in developing Chick embryo.
9. Changes in biochemical profiles of developing Chick embryo.
10. Morphological study of different types of placenta (ICT tools/ models/ charts/ photographs etc).

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MICROBIOLOGY

CORE: 16

Contact hours per Week – 6 hours **CREDITS: 4**

Contact hours per Semester – 90 hours **Subject Code:** P19ZYC41

Course Outcome:

CO 1: To gain the knowledge about the classification, Structure, Nutritional requirements and growth of Bacteria.
CO 2: To acquire an overall knowledge about Bacterial metabolism and diversity.
CO 3: End of the course can understand the role of bacteria in Environmental and Industry.
CO 4: To understand the role of bacteria in Foods and Agriculture.
CO 5: To Understand the impact of microorganisms in the health of human beings

Unit 1 **(18 Hours)**

General Bacteriology

General characters and classification of bacteria- Bacterial Morphology and staining- Ultra structure of Prokaryotic cell and function- Nutrition– Nutrient media and types –Culture methods– Pour plate, spread plate and streak plate. Synchronous, Continuous growth- Mode of nutrient uptake- Facilitated diffusion, active transport, group translocation and Iron uptake- Growth– Growth curve- Methods of measurement of growth– Factors influencing the growth of bacteria.

Unit II **(18 Hours)**

Microbial Metabolism

Bioenergetics and enzymes, Oxidation-Reduction, Energy conservation- ATP- Photophosphorylation, Oxidative phosphorylation and Substrate level phosphorylation- Electron transport carriers, Chemiosmosis, Inhibitors and uncouplers- Metabolic pathways- Glycolysis, Kreb's Cycle, Glyoxylate cycle and HMP shunt- Bacterial Photosynthesis- Purple bacteria, sulphur bacteria, Green bacteria, Purple non–sulphur bacteria, photosynthetic pigments, Oxygenic and anoxygenic photosynthesis, Calvin cycle.

Unit III **(18 Hours)**

Environmental and Industrial Microbiology

Microbiology of Air: Sources of microorganisms in air- Microbiology of Water: Water pollution, Microbes as pollution indicators, Water quality analysis by MPN method, Sewage treatment – Microbiological methods- Microbiology of Soil: microbes involved in nutrient cycles - Carbon, Phosphorus, Sulfur and Nitrogen- Bioremediation: Definition, In-situ and Ex-situ methods, Bioleaching of metal– copper, Biodegradation of Oil spill- Production of

organic acids- Citric acid and Vinegar- Production of alcoholic beverages- Beer and Wine- Production of antibiotics-Penicillin and Tetracycline.

Unit IV **(18 Hours)**

Food and Agricultural Microbiology

Fermented foods: Yoghurt, Cheese, Fermented meats, Fermented fish- Food spoilage: Spoilage of milk and milk products, meat and meat products- Food preservation: Pasteurization, Low and High temperatures, Filtration, Chemicals and Irradiations- Food borne Illness: Bacterial agents- Salmonella and Shigella, fungal agents– Aspergillus and Fusarium and viral agents– Polio and Hepatitis A & B- Symbiotic interactions of microbes- Microbe- Microbe symbiosis, plant-microbe symbiosis, Legume-Rhizobium interaction, animal-microbe symbiosis- Bioinsecticide- *Bacillus thuringiensis.*

Unit V **(18 Hours)**

Medical Microbiology

Infective processes and control of following diseases: Tuberculosis (Air Borne), Typhoid (Water borne) Dengue (vector borne), Tetanus (soil-borne) Gonorrhea and Syphilis (Sexually transmitted diseases), Genitourinary disease (Mycoplasmal disease), Candidiasis (Fungal disease) – Toxoplasmosis (Protozoan disease)- SAARS, H1N1 (Viral disease).

Text Books

1. Hans G. Schlegel, General Microbiology, 7th Edition, UK, Cambridge University Press 1995.
2. Ananthanarayanan, Jayaram Paniker, Text Book of Microbiology, 5th Edition, New Delhi, Orient Longman. 1997.
3. Pelczar M.J., Chan E.C.S., Kreig N.R., Microbiology, 6th Edition, New Delhi, Tata McGraw Hill Pub. Co. Ltd. 2007.

Reference Books

1. Frazier W.C., Westhoff D.C., Food Microbiology, 4th Edition, New Delhi, Tata McGraw Hill Pvt. Ltd. 1995.
2. Adams and Moss, Food Microbiology, New Age International Publishers, New Delhi 1995.
3. Casida L.E., Industrial Microbiology, Wiley Eastern Ltd.1993.
4. Prescott, Harley, Klein, Microbiology, 4th Edition, New Delhi, WCB McGraw Hill Co. 1999.
5. Stainer R.Y., Doudoroff M, Addberg E.A., General Microbiology, 3rd Edition, MacMillan India 1970.
6. Ronald M Atlas, Principles of Microbiology, 2nd International Edition, New Delhi, McGraw Hill. 1997.
7. Michael T. Madigan & John K.Martinko, Brock Biology of Microorganisms, 11th edition, Pearson Prentice Hall, Printed in USA. 2006.
8. David Greenwood, Richard Slack and John Peutherer, Medical Microbiology, 15th Edition, ELST Publishers. 1997.
9. Talaro, K. & Talaro, A. Foundations in Microbiology, Third edition, Dubuque, McGraw Hill. 1999.

10. Tortora G.J., Funke, B.R. & Case C.L. Microbiology: An Introduction, 6th edition, Benjamin/Cummings Publishing, Menlo Park California. 1999.

ANIMAL PHYSIOLOGY

CORE: 17

Contact hours per Week – 6 hours **CREDITS: 4**

Contact hours per Semester – 90 hours **Subject Code:** P19ZYC42

Course Outcome:

CO 1: To learn the importance of nutrients, digestion of food and its metabolism.
CO 2: To understand the structure and physiology of various organ systems in animals.
CO 3: To gain knowledge about nervous system in humans and sense organs of animals.
CO 4: To study types, ultrastructure and role of muscles in animal movement.
CO 5: To reveal the role of hormones in physiological processes.

UNIT – I **(20 hours)**

Nutrition and Digestion

Nutritional requirement– components of adequate diet- Digestion– Intracellular and Extracellular digestion– digestion and absorption of carbohydrate, protein and fat– co-ordination of digestive activities- control of digestive secretions- Metabolism: metabolic rate, metabolism of carbohydrate, protein and fat- Respiratory quotient, Energy storage.

UNIT – II **(20 hours)**

Respiration, Circulation Excretion and Osmo & Thermo regulation

Respiratory Organs: Trachea in insects, Gills in fishes and Lungs in human- respiratory pigment: Haemoglobin– transport of oxygen and carbon dioxide– physiological adaptation at high altitudes and in deep sea- Body fluids– patterns of circulation in vertebrates– structure and functions of pacemaker – regulation of blood flow and blood pressure– valves and stopcock, elasticity of blood vessels and sustained pressure, peripheral resistance, vasomotor reflexes, vasoconstrictor and vasodilator substances- Excretion of nitrogenous wastes: ammonotelic, ureotelic and uricotelic animals- Osmoregulation: osmoregulators and osmoconformers- osmoregulation in aquatic, terrestrial and desert animals- Osmoregulatory organ: kidney– ultrastructure and functions of Nephron- Ectotherms and endotherms– mechanism of temperature regulation.

UNIT – III **(15 hours)**

Nervous system and Sensory organs

Central and Peripheral nervous system- Neuron: structure- Transmission of signals in a single neuron– synaptic transmission- measuring membrane potentials– resting, action potentials– ionic basis of action potential– neurotransmitter substances– pharmacological effects of neurotransmitters- General account on Sense organ in vertebrates: chemoreceptor (Taste buds), mechanoreceptor (Ear), thermoreceptor (Skin) photoreceptor (Eye).

UNIT – IV **(15 hours)**

Muscle and Movement

Types of muscle– ultrastructure of striated muscle– contraction of sarcomere– sliding filament theory– role of calcium ion– cross bridge attachment– excitation– contraction coupling– neuromuscular junction– insect flight muscle– physiology of electric organ in Electric ray.

UNIT – V **(20 hours)**

Endocrine glands and reproduction

Glandular secretions: endocrine glands, endocrine systems– chemical types– regulation of hormone secretion– glandular hormones– neurohormones – mechanism of hormone action– metabolic hormones: glucocorticoids, catecholamines, growth hormones, insulin, thyroxine, epinephrine and norepinephrine- Hormonal control of water and electrolyte balance– antidiuretic hormone, aldosterone, parathormone and Calcitonin Reproductive hormones: male and female sex hormones in human- Menstrual cycle- Oestrous cycle in mammals.

Text Books:

1. Nagabhushanam R., Kodarkar M.S., Sarojini R. *Text Book of Animal Physiology* (2 nd Edition). Oxford & IBH; (1999).
2. Hoar W.S. *General and Comparative Physiology* (3 rd Edition). Prentice Hall of India; (1984).

References

1. Eckert *Animal Physiology : Mechanisms & Adaptations*(4 th Edition). New York: Randall D., Buurggren W., French K. W.H. Freeman and Company; (1997).
2. Knut Schmidt Nielson *Animal Physiology: Adaptation and Environment*(4 th Edition). Cambridge University Press; (1994).
3. Prosser C.L.*Comparative Animal Physiology*(3 rd Edition). W B. Saunders Company;(1984).

BIOTECHNOLOGY

CORE: 18

Contact hours per Week – 6 hours **CREDITS: 4**

Contact hours per Semester – 90 hours **Subject Code:** P19ZYC43

Course Outcome:

CO 1: To gain the knowledge and familiarize the tools and techniques of genetic engineering.
CO 2: End of the course can understand the gene transfer and gene cloning methods.
CO 3: To gain the knowledge about animal cell culture and tissue culture.
CO 4: To understand the applications and advantages of biotechnology in Industries.
CO 5: To gain the idea about role of biotechnology in bioremediation, healthcare, safety and legal issues.

Unit I **(18 Hours)**

Tools of Genetic engineering

Cloning vectors: Properties of a cloning vector- Types of cloning vectors: plasmids (pBR322, pBR327, pUC); phages (lambda phage, M13); cosmids, Phagemids, virus- SV40, BAC, YAC and MAC- Shuttle vectors and expression vectors- Enzymes for rDNA technology: Restriction enzymes and Ligases- cDNA Bank and Gene Bank- DNA Sequencing: Maxam and Gilbert's chemical degradation method, Sanger's dideoxynucleotide synthetic method- Gene mapping: DNA Microarray in Gene Mapping.

Unit II **(18 Hours)**

Methods of Gene cloning

Gene cloning in *E. coli*, Yeast, Plant and animal cells- Construction of chimeric DNA (Blunt end ligation, cohesive end ligation, homopolymer tailing, use of linkers)- Gene transfer methods: Transformation, Electroporation, Microinjection, Shot gun cloning, liposome mediated gene transfer, DEAE- Dextran, Viral vectors- Selection of clones- blue white

selection method, colony hybridization and Plaque hybridization- Amplification- Multiplication, Expression and integration of the DNA insert in host genome.

Unit III **(18 Hours)**

Animal Cell Culture Techniques

Composition and Types of Culture media- Bioreactors: Types- Establishment of Primary culture and cell line- Disaggregation of Tissue: Physical and Chemical method- Types of culture: Tissue culture, Organ culture, Embryo Culture- Cryopreservation of cell lines- IVF and Embryo transfer in human and farm animals- Method of production of transgenic animals and their applications- Stem cells: Characteristics and applications.

Unit IV **(18 Hours)**

Industrial Biotechnology

Isolation of microbes for enzyme production- Methods of strain improvement for industrially important secondary metabolites- Downstream process: Centrifugation, Extraction, Purification, Product recovery- Fermenter design- Applications of microbes in industrial biotechnology: Cellulose utilization, Alcohol production and Antibiotic biosynthesis- Enzyme immobilization: Methods of immobilization: Coupling, Covalent Binding, Cross Linking, Adsorption, Entrapment, Microencapsulation- Applications of immobilized enzymes.

Unit V **(18 Hours)**

Biotechnology and Healthcare

Vaccine: Production of recombinant vaccine, DNA vaccine- Disease Diagnosis: DNA as Diagnostic and Therapeutic agent- Recombinant DNA in Medicine- rDNA and Environment: Biosensors, GMO in Bioremediation of heavy metals and tetrachloroethylene- Ethics of rDNA technology: Hazards of Biotechnology- Human safety- Animals and ethics, BRAI- Legal issues: IPR, Patent, Copyright, Trade secrets and Trademarks.

Textbooks:

1. S.C. Rastogi. *Biotechnology: Principles and Applications*.New Delhi: Narosa Publishing House Pvt Ltd;2009.
2. R.C. Dubey. *A Textbook of Biotechnology*.New Delhi: S. Chand & Company Ltd;2012.
3. P.K. Gupta. *Elements of Biotechnology*.Meerut:Rastogi Publications;2003.

Reference books:

1. R.W. Old and S.B Primrose. *Principles of Gene Manipulation*(5^{th} Edition). New Jersey: Blackwell Science;1996.
2. B.R.Glick and J.J. Pasternack. *Molecular Biotechnology: Principle and Applications of Recombinant DNA* (2^{nd} Edition).Newyork: ASM Press;1988.
3. E.J. Higgins, D.J Best and J. Jones. *Biotechnology: Principles and Applications*.New Jersey: Blackwell Science;1988.
4. E.L Winnacker. *From Genes to Clones: Introduction to Gene Technology*.New Delhi: Panima Educational Book Agency.1987.
5. James D Watson, Michel Gilman, Jan A Witkowski and Mark Zoller. *Recombinant DNA* (2^{nd} Edition).Newyork: Scientific American Books published by W.H. Freeman; 1992.

PROJECT WORK

Credit-5 **Sub code:** P19ZY4PV

Hours/week-6

Objectives:

The aim of project work (lab work) is to inculcate students to learn adequate knowledge on research methodology in the subject and prepare them for pursuing research in experimental or computational areas of the subject. Student's allotment is done by lot system. The project work study is to be undertaken under the guidance of a Teacher of the Department. The guiding teacher will make continuous internal assessment of the Project Work. No teacher shall be permitted to guide more than three students in a semester for Project Work under his/her supervision. The project work will be evaluated by the external examiner.

- Project will be done by the final year students in the fourth semester under the guidance of respective guides.
- For projects internal marks (max 50) will be awarded by the respective guide and external marks (max 50) will be awarded in the external examinations.
- Minimum number of pages for M.Sc. Project thesis shall be 40.

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LAB: MICROBIOLOGY

CORE: 19

Contact hours per Week – 3 hours **Credits: 3**

Contact hours per Semester – 45 hours **Subject Code: P19ZYP41**

1. Sterilization techniques - Hot air Oven, Autoclave, Membrane filter and Radiation
2. Preparation of culture media (Liquid and Solid) and agar slants for microorganisms.
3. Counting of viable cells by serial dilution – Spread plate and streak plate.
4. Total microbial count in soil sample by pour plate method
5. Motility determination
6. Standard qualitative analysis of drinking water – MPN method
7. Estimation of microflora of milk by Methylene Blue Reduction (MBR)
8. Differentiation of bacteria by Gram staining
9. Biochemical Test- Catalase
10. Extracellular enzyme activities of microorganisms – Amylase
11. Antibiotic sensitivity test

LAB: ANIMAL PHYSIOLOGY

CORE: 20

Contact hours per Week – 3 hours **Credits: 3**

Contact hours per Semester – 45 hours **Subject Code: P19ZYP42**

1. Effect of temperature on oxygen consumption in fish
2. Effect of temperature on opercular movement in fish
3. Effect of salinity on oxygen consumption in fish
4. Study of permeability of biological membranes
5. Salt loss in fish
6. Salt gain in fish
7. Qualitative examination of haemin crystals
8. Qualitative analysis of Glucose and Urea in urine sample. (Cow urine)
9. Qualitative analysis of digestive enzymes in cockroach and fish.
10. Spotters: Sphygmomanometer, Kymograph, Haemoglobinometer and Electrocardiogram